HOST-PARASITE RELATIONS OF THE FOWL TAPEWORMS *RAILLIETINA CESTICILLUS* AND *CHOANOTAENIA INFUNDIBULUM*

BY

NORMAN AUGUST MEINKOTH

B.Ed., Southern Illinois Normal University, 1938

M.S., University of Illinois, 1944

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
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ACKNOWLEDGMENT

This work was done under the direction of Dr. L. J. Thomas, whose interest and encouragement, helpful suggestions and patience are hereby acknowledged.

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After attempts to infect different insects including houseflies, grasshopper nymphs, various carabid, dermestid, and tenebrionid beetles with larval stages of fowl cestodes it was found that meal beetles of the genus *Tribolium* were quite susceptible to infection by the larvae of *Raillietina cesticillus* and *Choanotaenia infundibulum*. The method subsequently developed which produced greatest infections consisted of isolating from 250 to 500 *Tribolium* without food in pint screwcap jars which were jacketed with paper to exclude light and which contained circles of paper toweling in which the beetles could hide. Whole segments or proglottids of the tapeworms were collected daily from droppings of infected chickens, and from 25 to 50 were crushed and mixed with a small amount of dry rolled oats, and placed in the jar. A series of ten such daily feedings infected as high as 65 per cent of a given lot of *Tribolium* with cysticercoids of *R. cesticillus* and 100 per cent infections with *C. infundibulum* were common.

Experiments were devised to test the viability of the tapeworm onchospheres or ova as shown by their ability to produce subsequent infections in lots of *Tribolium*. Onchospheres of *R. cesticillus* which were held at room temperatures in saline for 24 hours or at 4° C in saline for 24 hours produced as many cysticercoids in the beetles (63 per cent and 56 per cent, respectively) as onchospheres fed immediately after collection (60 per cent). Those held frozen for 24 hours were slightly less infective (52 per cent). However, if held under any of these three conditions for 48 hours their infectivity dropped rapidly (16 per cent, 11 per cent, and 8 per cent, respectively). If onchospheres were held frozen for as long as 144 hours their viability remained about the same as those frozen for 48 hours (17 per cent). Desiccation, freezing on dry ice, or storage in saline at 37° C for 24 hours rendered all onchospheres uninfective, although an 8 per cent infection was obtained from some held 12 hours at 37° C.

Onchospheres of *C. infundibulum* retained their infectivity somewhat better. The control sample in which fresh onchospheres were fed a lot of beetles yielded 100 per cent infection. No significant decrease in infectivity was produced by storage in saline at room temperature for 24 hours (100 per cent), for the 48 hours (92 per cent), by storage at 4° C for 24 hours (98 per cent), by freezing 24 hours (100 per cent), 48 hours (98 per cent), or 72 hours (92 per cent). However, those held frozen for 96 hours showed a reduction in viability by producing only a 60 per cent infection in the lot of beetles. As in the case of *R. cesticillus*,

onchospheres of *C. infundibulum* were killed by freezing on dry ice and by desiccation, but unlike the former, these cestode eggs produced 94 per cent infection after 24 hours storage in saline at 37° C.

Onchospheres of *R. cesticillus* are frequently observed to begin spontaneous hatching, especially after previous chilling. Proglottids were collected and stored in both saline and distilled water and subjected to various temperatures to determine the conditions optimum for this activity. Onchospheres from freshly collected proglottids showed only slight tending to hatch (6 per cent) in saline, not at all in distilled water. Ten minutes chilling on ice cubes did not significantly change this tendency. But when proglottids were stored from 3 to 24 hours at 4° C, from 38 to 72 per cent began hatching immediately when brought to room temperature, whether in saline or water. Those which commenced hatching in water began swelling as soon as they burst through their inner egg envelope. This envelope served to protect onchospheres which remained inactive from the hypotonicity of the water medium. If the distended onchospheres were taken from water and placed in isotonic saline within 20 minutes many (47 per cent) returned to normal size and resumed activity, some (100 per cent) successfully hatching. After 40 minutes in water, however, none survived.

Onchospheres of proglottids which had been frozen in distilled water showed no hatching movements upon being brought to room temperatures, and only 5 per cent of those frozen in saline for 3 hours hatched. A saline extract of crushed *Tribolium* bodies showed was no more effective in inducing hatching than plain saline solution.

Periodicity of appearance of proglottids in the droppings of chickens was observed for both species of tapeworm. In a total fecal sample collected at 2 and 4 hour intervals from 6 chickens heavily infected with *R. cesticillus* it was found that 74 per cent of the proglottids appear between 3:00 P.M. and 7:00 P.M. A total fecal sample collected from 4 chickens with light to moderate infections of *C. infundibulum* showed that 54 per cent of all proglottids were passed between 2:00 P.M. and 6:00 P.M. Although the later worm shows definite cyclic tendencies in proglottid release the peak seems to come somewhat earlier, is not so sharp, and the whole shedding period covers a greater time span.

Four chickens, two infected with one cestode, and two with the other, were placed in cages from which natural light was excluded, and which were equipped with 150 watt lamps on a system equipped with a Tork timer. Their photoperiod was then adjusted so that light came on at 8:00 P. M. and went off at 11:00 A. M. After 13 days a total fecal sample was collected over 24 hours, revealing that the time of the peak of proglottid release had changed, *R. cesticillus* producing 68 per cent of the output between 6:00 A. M. and 10:00 A. M. and *C. infundibulum*

producing 62 per cent during the same period. It is believed that the release of proglottids, a result of worm growth, is directly dependent upon the presence of available food in the gut of the chicken. The nightly fast of the chicken causes a fluctuation in this availability.

Attempts were made to immunize white plymouth rock and white leghorn chickens of various ages with whole live worms, ground live or dead worms, suspended in saline and cysticercoids introduced intraperitoneally. In six different experiments using 53 individual chickens thus treated sustained infections of tapeworms not significantly different from those of untreated controls given similar infective feedings of cysticercoids.

Ring precipitin tests were devised, using layers of chicken plasma overlain with saline extract of ground fresh or dried worm material. No antigen-antibody precipitate was demonstrable in the plasmas of chickens of any age even though their worm burden was heavy. However, the antigenicity of the worm body is demonstrated by the appearance of precipitates when plasmas from chickens which had received intraperitoneal injections or implantations of the homologous worm were used.

An age resistance to *R. cesticillus* was demonstrated in chickens 188 days old both in the numbers of adult worms sustained after oral administration of infective cysticercoids and in the prepatent period. In the latter case proglottids appeared at 11 days in the droppings of chickens aged 7 days and 63 days at the time of infection, while those 188 days showed no proglottids until the 23rd day after the infective dose. 2.0 ml. injections of adult rooster serum administered 3 times at 4 day intervals imparted no protection to young chicks, suggesting that the mechanism of age resistance to this worm is not a serological phenomenon.

VITA

Norman August Meinkoth was born in New Baden, Illinois, January 29, 1913. He attended the public schools of New Baden, Lebanon, and O'Fallon, Illinois, and was graduated from the O'Fallon Township High School in May, 1931. In 1934 he enrolled in the Southern Illinois Normal University from which he was granted the B. Ed. with Honors in June, 1938, with a major in zoology.

From September, 1938 until May, 1941 he was biology instructor at Herrin Township High School, Herrin, Illinois. He attended the summer session of the University of Wisconsin in 1939, and the summers of 1941 and 1942 were spent at the University of Michigan Biological Station where he was Assistant in Helminthology during the second summer.

In September, 1941, he came to the University of Illinois as Assistant in Zoology. During the academic years of 1943-44 and 1944-45 he was full-time assistant. The M.S. degree was granted in February, 1944. He attended the Marine Biological Laboratory at Woods Hole, Massachusetts, during the summer of 1946.

Honorary and professional societies of which he is a member include Sigma Xi, Phi Sigma, Kappa Phi Kappa, Gamma Theta Upsilon, the American Microscopical Society, the American Society of Parasitologists, and the American Association for the Advancement of Science.

Publications:

Notes on the Life Cycle and Taxonomic Position of *Haplobothrium globuliforme* Cooper, a Tapeworm of *Amia Calva* L. Accepted for July, 1947 issue, Trans. Amer. Micr. Soc.